GUS-0037
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RECD 15 May 1958

Discussion of Radar Cross Section of Aircraft as Function of Range & Altitude

Statement of the Problem

As an aircraft approaches a radar network it must approach the bottom of some radar beam usually a TWS (Track-while-Scan) type ~~radar from the bottom of the beam.~~ This fact is basic due to the curvature of the earth. As the craft approaches the radar it passes through the beam and emerges above the particular beam ~~of a typical TWS radar.~~

Radars of the search type concentrate energy between 2° and 14° above the horizon in an attempt to detect aircraft at the earliest possible point in their approach to the radar. See Figure 1.

Typical numbers for this passage through the beam [illegible] radar are as follows: For an aircraft at 70,000 feet in altitude the low edge of the 2° beam is entered at 170 miles distance from the set and the aircraft emerges at a 10° angle some 70 miles from the set when flying directly towards the radar. At 90,000 feet these numbers become 190 miles for entry and 90 miles for emergence. see attached profile chart

The problem at hand is to so construct an aircraft that its cross section during passage through the beam is so small as to be in the noise level of the radar in question during passage through this beam.

Stated another way - how many square meters of cross section can radars see at ranges of 70 to 170 miles or 90 to 190 miles at the two altitudes under discussion?

Discussion

The radars in question occur in the frequency spectrum at 70, 600, 3,000 mc. So the tolerable cross section must be studied for each of these frequencies. ~~and~~ and for each antenna pattern.

Furthermore radar signals vary as the fourth power of range so the aircraft is most observable when nearest the radar. The two cases above occur at 70 and 90 miles for the 2 altitudes and give a ratio of -

$$\frac{(70)^4}{(90)^4} = \cancel{4.8\ db}\ 4.3\ db$$

This means that a change from 70 to 90,000 feet in altitude gives approximately 5 db improvement in the detectable signal.

A detailed discussion of the antenna patterns at various frequencies and resultant minimum area requirements follows.